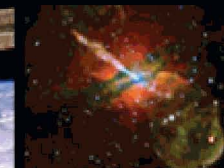
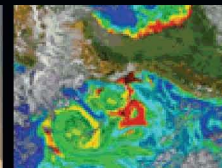


National Aeronautics and Space Administration



Product Lifecycle Management and the Quest for Sustainable Space Transportation Solutions

marshall



www.nasa.gov

Pamela W. Caruso, Manager
Engineering Technical Management Office
Engineering Directorate
NASA Marshall Space Flight Center
June 24, 2009

NASA Strategic Goals

Retire the SHUTTLE in 2010

Complete the INTERNATIONAL SPACE STATION

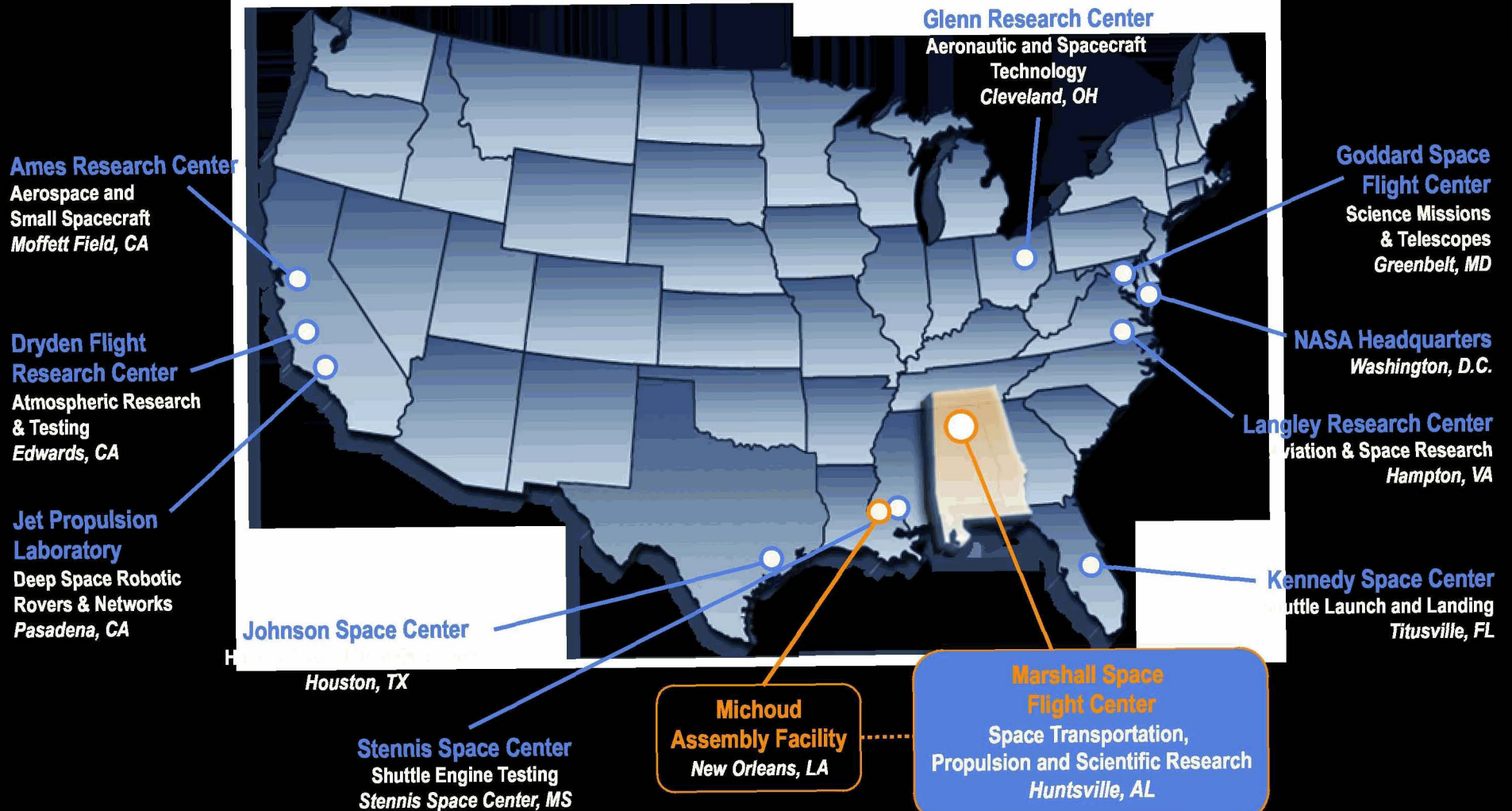
Establish a PERMANENT presence on the MOON

Bring the new EXPLORATION VEHICLES into service

Develop a BALANCED PROGRAM of science, exploration and aeronautics

Pursue PARTNERSHIPS with commercial space sector

NASA Around the Country



**Marshall Collaborates with NASA Centers,
Government Agencies, Industry, & Academia**

Marshall's Product Lines



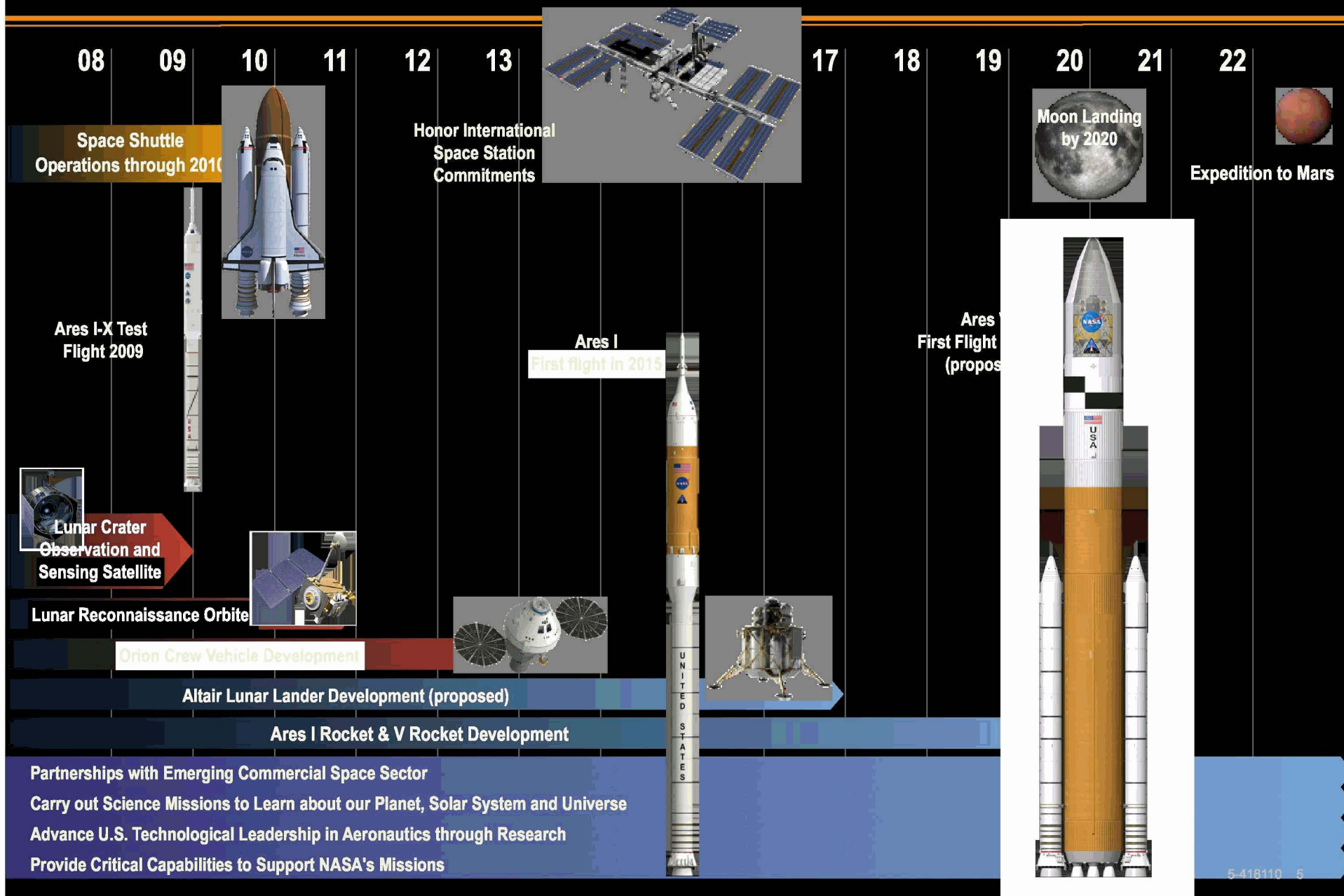
**Earth and Space Science
Spacecraft, Systems, and
Operations**

Life Support Systems

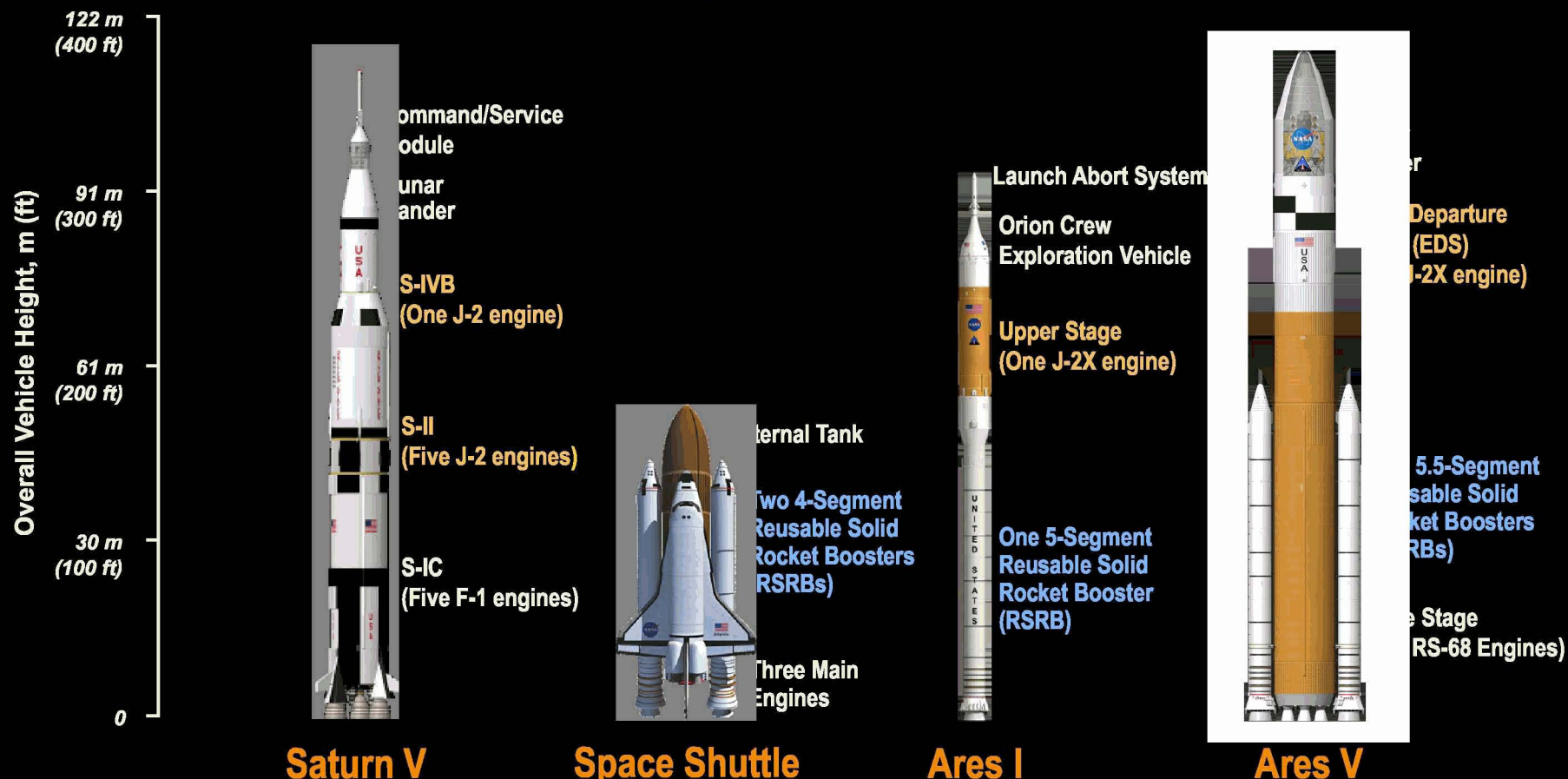
**Propulsion and
Transportation
Systems**

The Space Enterprise Needs Sustainable Solutions

Exploration Timeline



Marshall Builds on 50 Years of Proven Experience



Saturn V

Space Shuttle

Ares I

Ares V

1967–1972

1981–Present

First Flight 2015

First Flight 2020 (proposed)

mT – metric tons
TLI – Trans-Lunar Injection
LEO – Low Earth Orbit

Height:
110.6 m (363 ft)

Payload Capability:
44.9 mT (99,000 lbs) to TLI
118.8 mT (262,000 lbs) to LEO

Height:
56.1 m (184.2 ft)

Payload Capability:
25.0 mT (55,000 lbs) to LEO

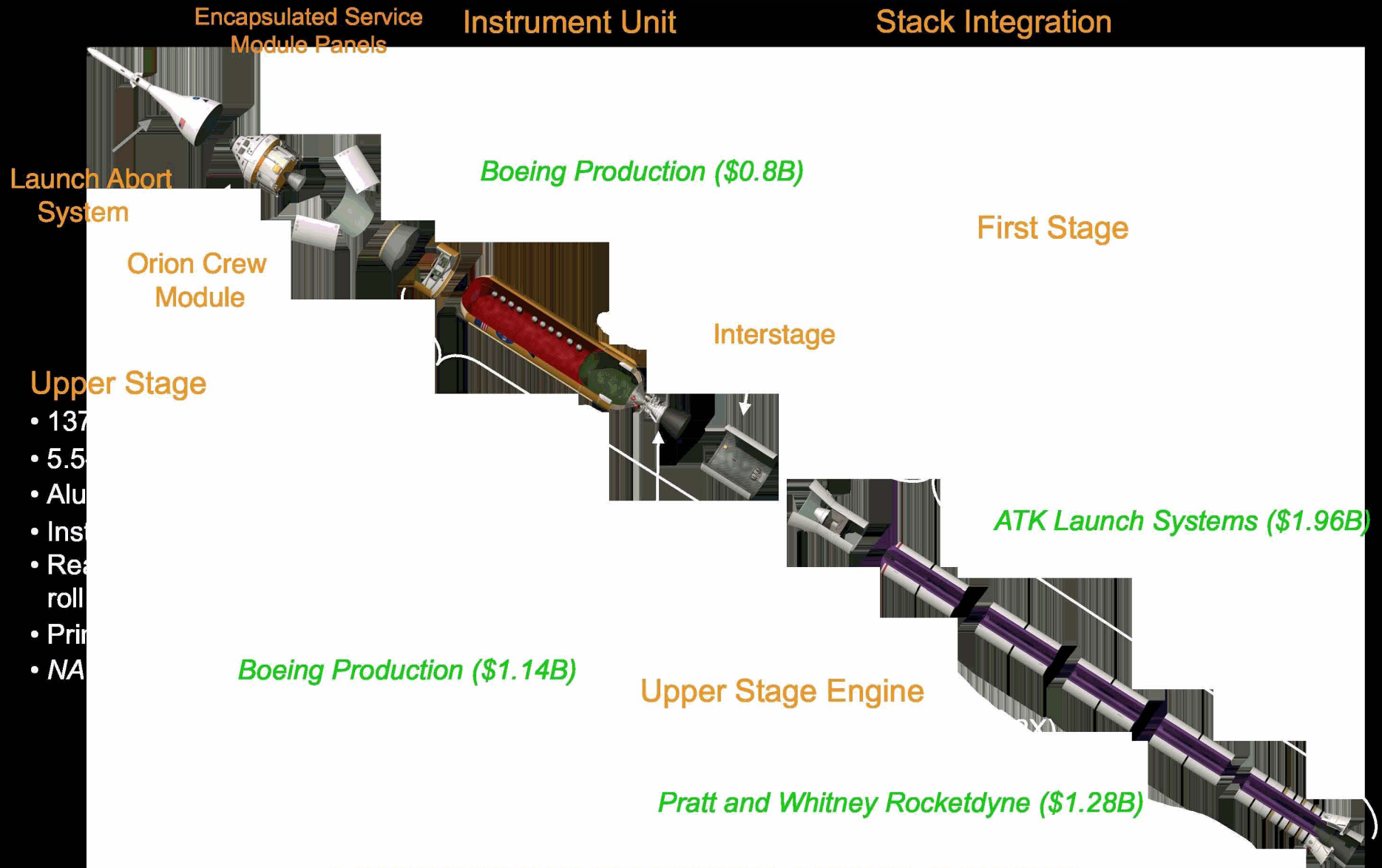
Height:
99.1 m (325 ft)

Payload Capability:
25.5 mT (56,200 lbs) to LEO

Height:
116.2 m (381.1 ft)

Payload Capability:
187.7 mT (413,800 lbs) to LEO
71.1 mT (156,700 lbs) to TLI with Ares I
62.8 mT (138,500 lbs) direct to TLI

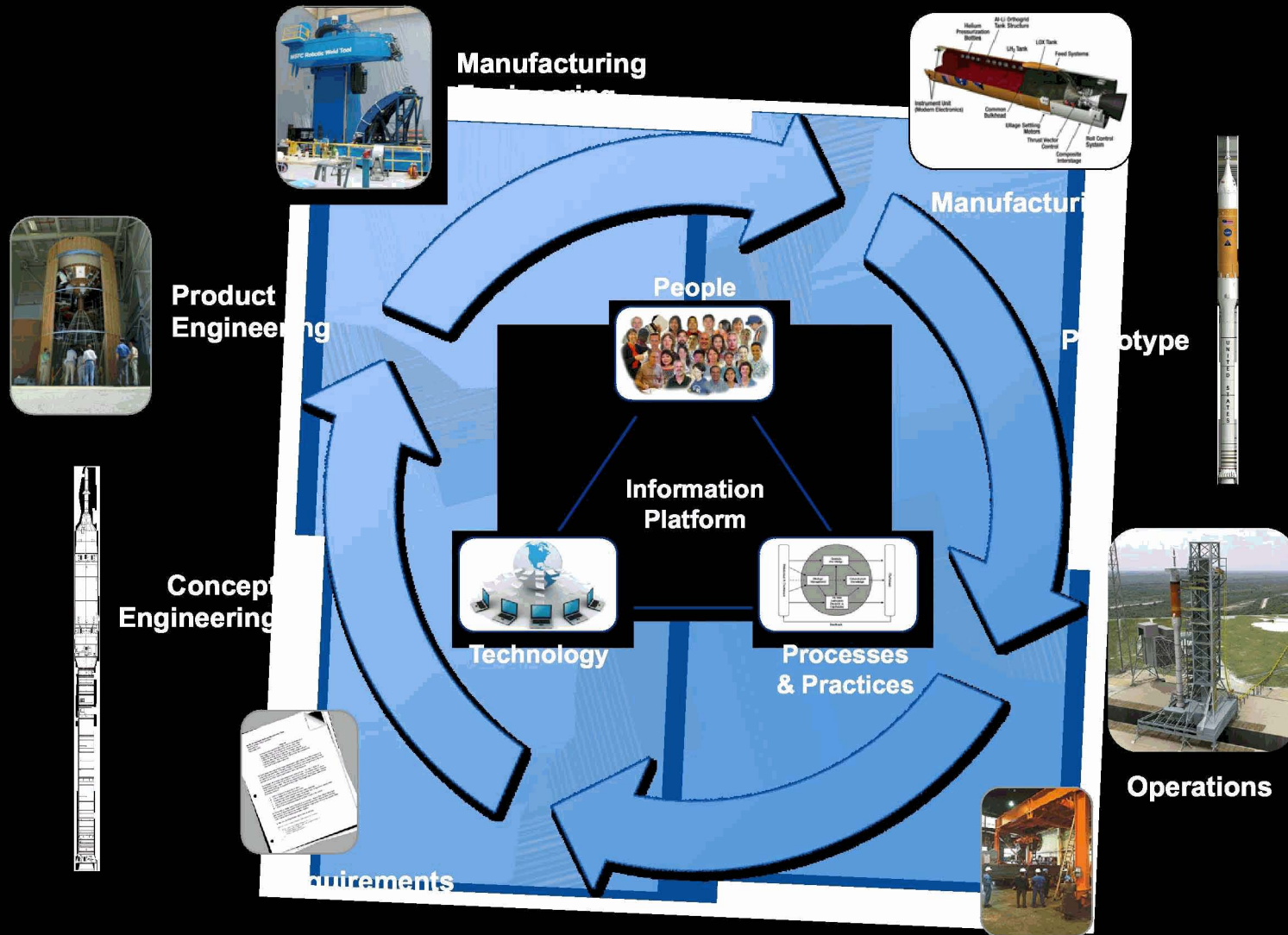
Ares I Crew Launch Vehicle Elements



Upper Stage

- 137
- 5.5
- Alu
- Ins
- Rea
- roll
- Pri
- NA

Product Lifecycle Management Model: Ares I



PLM Reduces Risk through Integration

Information Platform

- Provide the right information to the right people at the right time

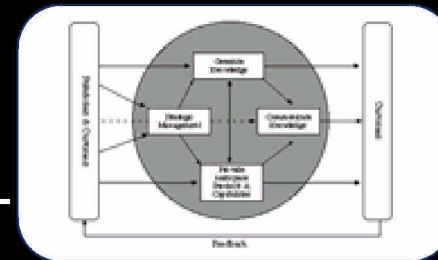
People



Information Platform



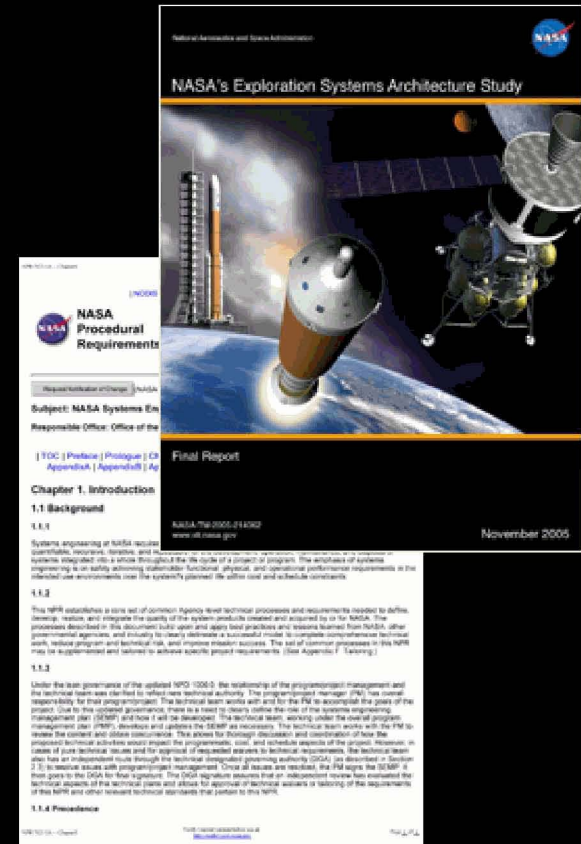
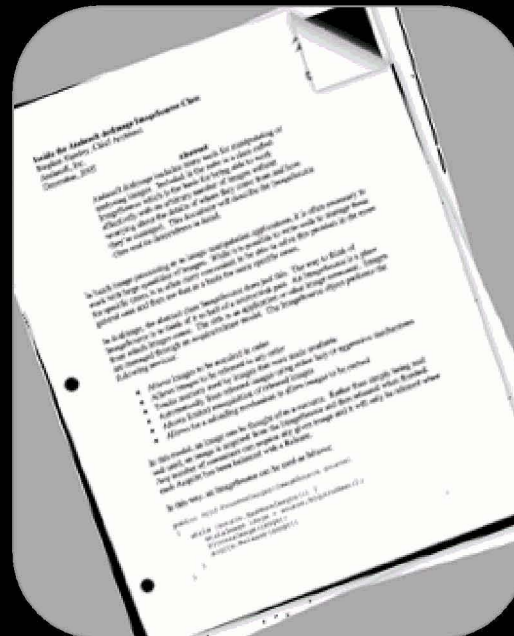
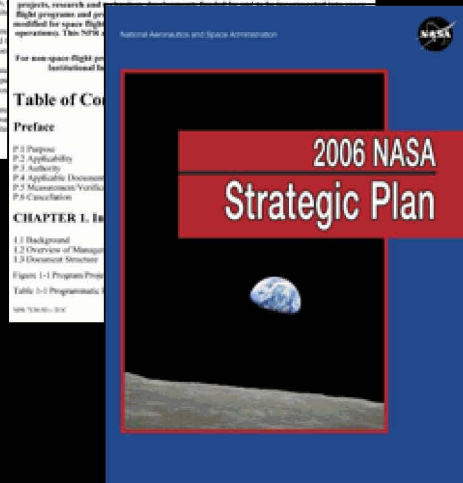
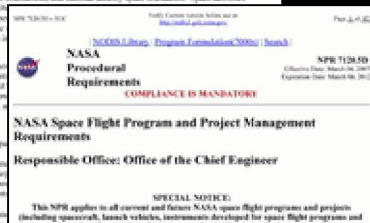
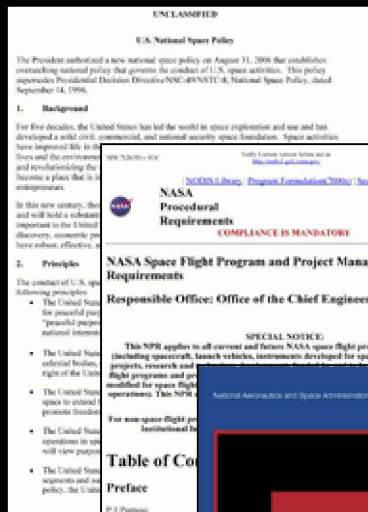
Technology



Processes & Practices

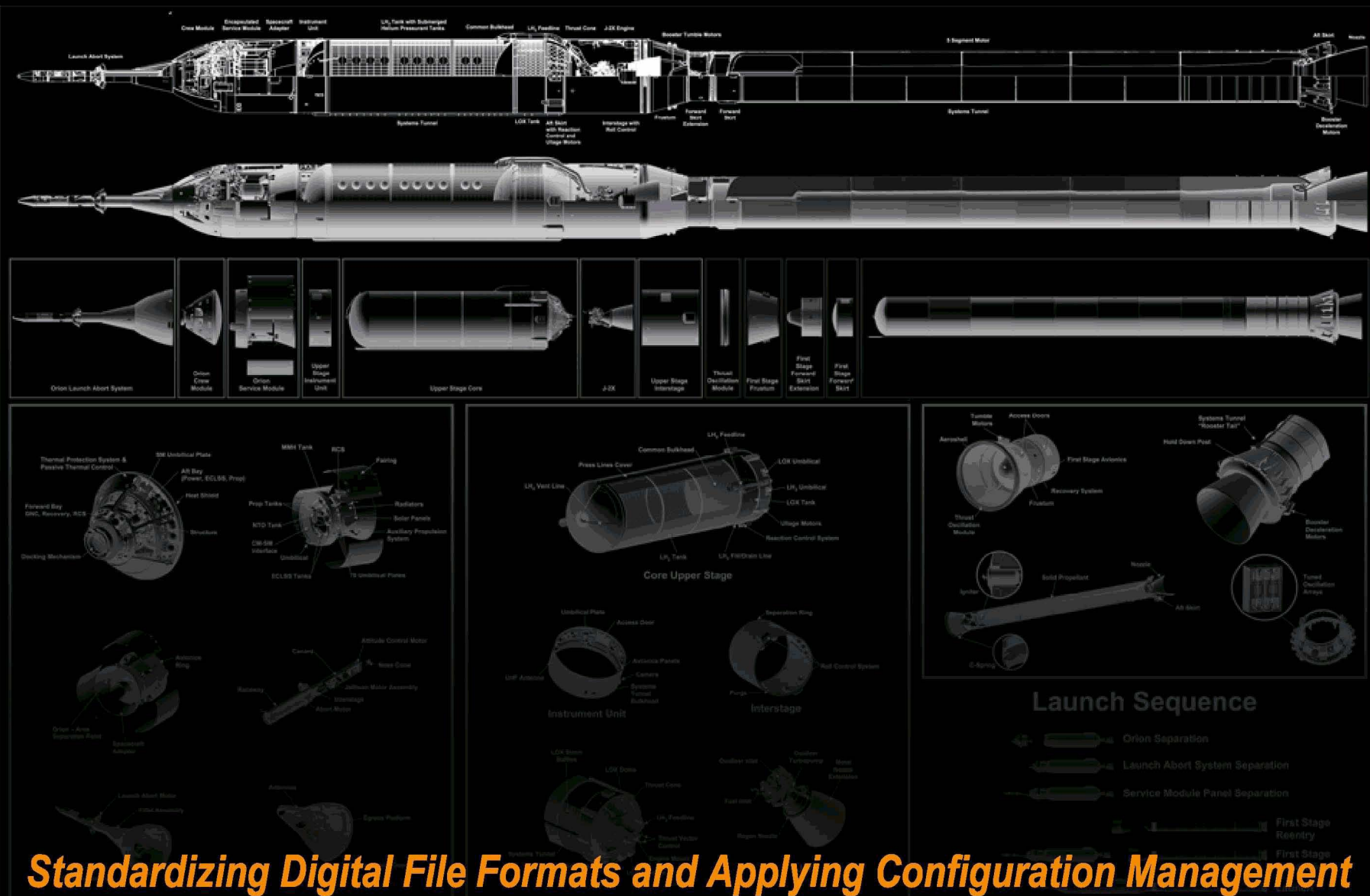
The Enterprise Is Constantly Evolving and Adapting

Requirements: The Foundation for Stakeholder Satisfaction and Product Goals and Objectives



NASA Policy, Regulations, and Standards Underpin Work Scope

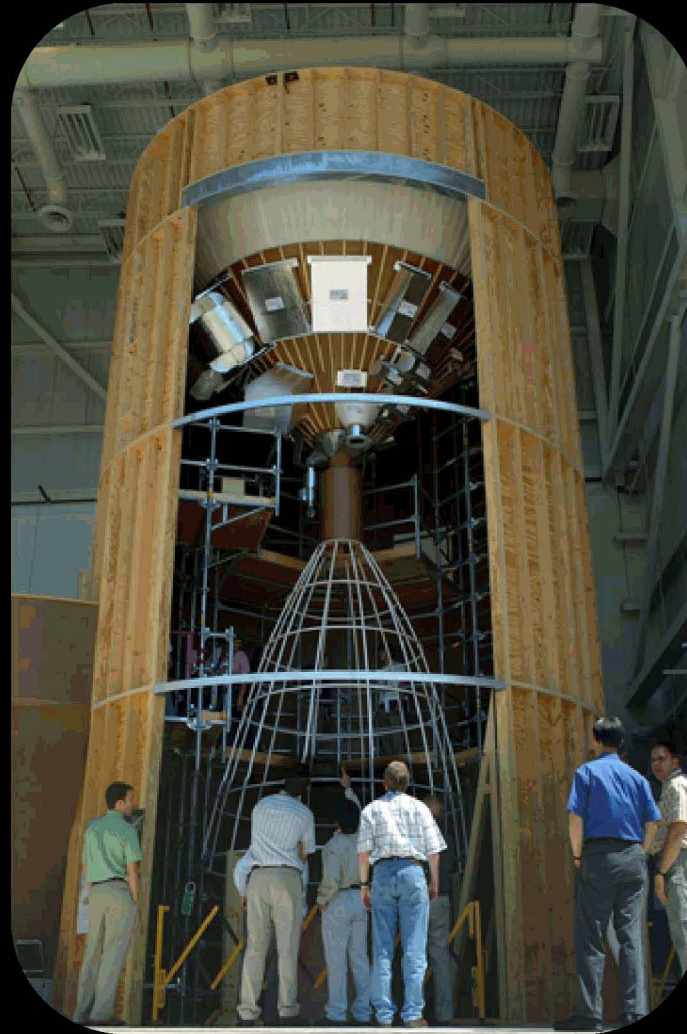
Concept Engineering: Closing the Design Case



Standardizing Digital File Formats and Applying Configuration Management

Product Engineering: Checking the Digital Design

- Fit checks: form follows function
- Meet mandatory and desired requirements
- Check the 2-D design in 3-D
- Refine the math-based CAD model



Moving from Bits and Bites to Brick and Mortar

Manufacturing Engineering: Testing Before Building

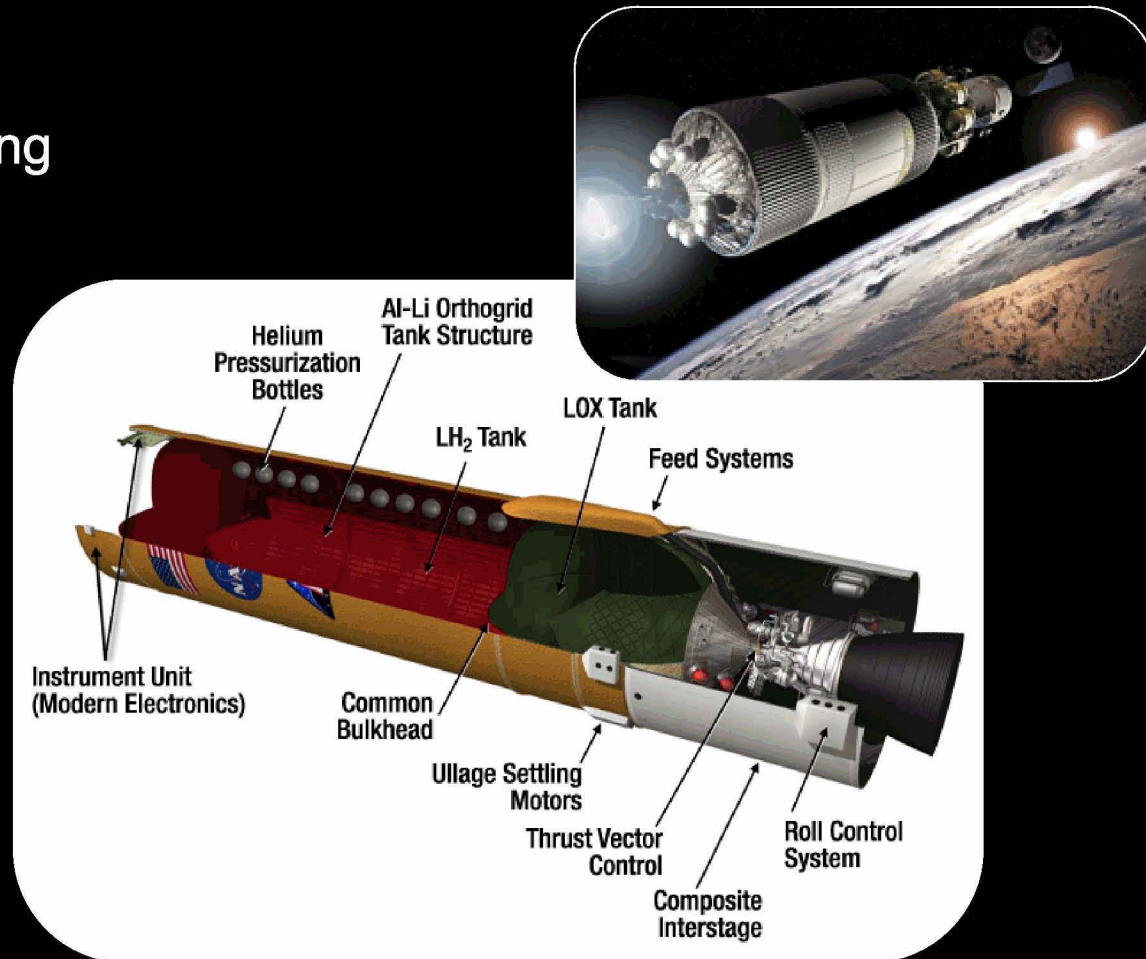
- Ground support equipment specifications
- Assembly instructions
- Materials selection and process development
- Refine the math-based CAD model



Point of Most Return on Investment

Manufacturing: As-Built Design

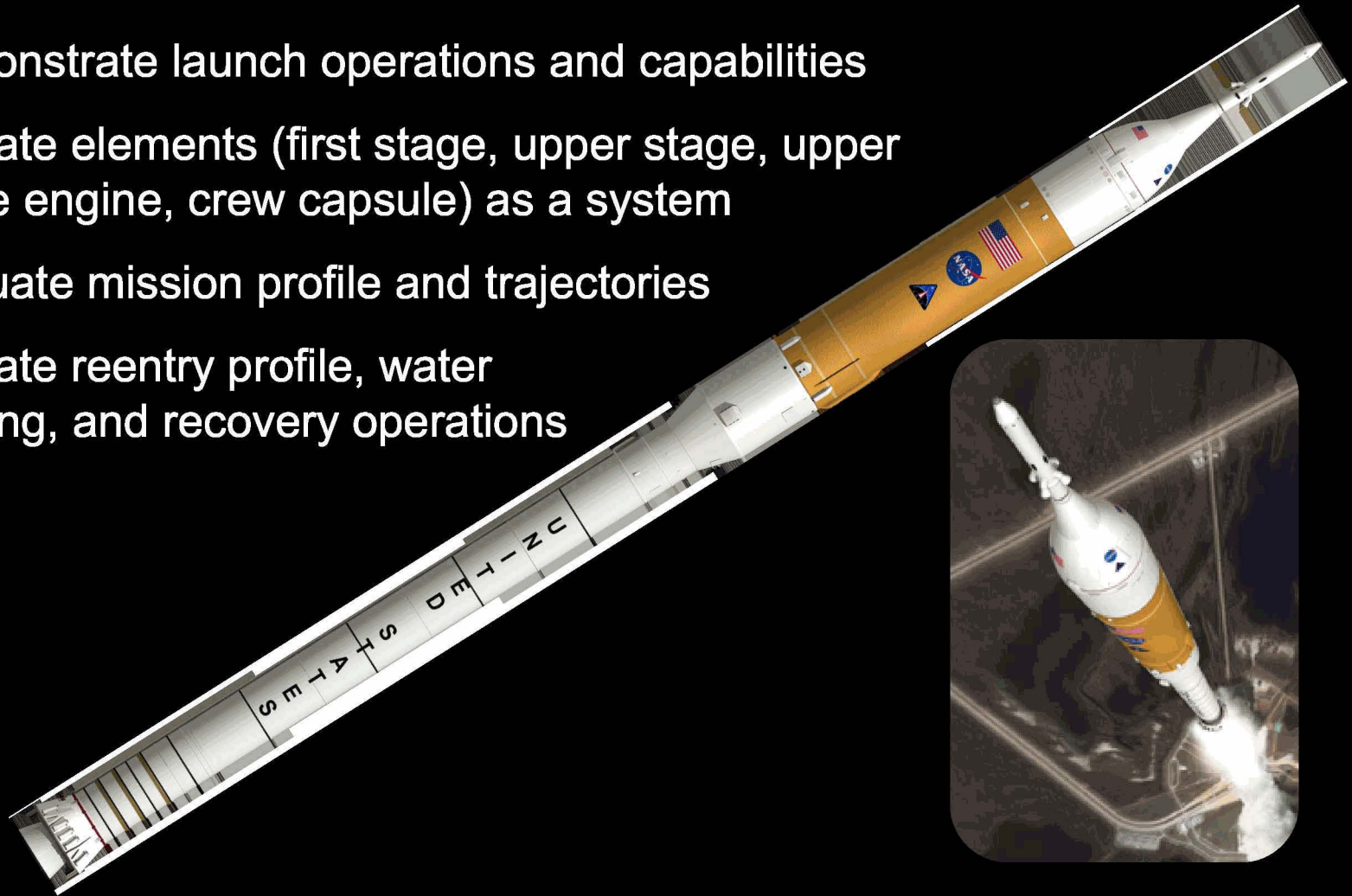
- Model-based design reduces time to fielding
- Quality issues are pre-addressed
- Cost reduction due to streamlined processes
- Retrofitting the Michoud Assembly Facility



Harnessing Unique Aerospace Facilities and Expertise

Prototype: Testing in Real-World Environments

- Demonstrate launch operations and capabilities
- Validate elements (first stage, upper stage, upper stage engine, crew capsule) as a system
- Evaluate mission profile and trajectories
- Validate reentry profile, water landing, and recovery operations



Flying on Auto-pilot to Validate Critical Systems in Real-World Scenarios

Operations: As-Maintained System

- 80% of costs determined during concept development
- Operability = availability + affordability
- Evolved expendable launch vehicle model
- Sustaining engineering



Reducing Complexity for Robust Launch on Demand

Decommissioning: The Real Cost of Retirement

- Disassembly drawings
- Efficient recycling and disposal planning
- Maximum reuse of materials
- Minimum use of toxic and hazardous waste



Factoring Environmental Concerns into the Design Trade Space

Why Explore?

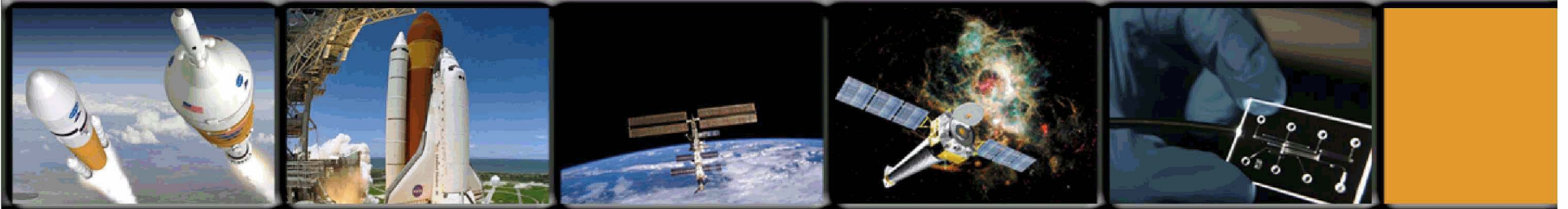
To uphold America's leadership through:

Technological Advancement

Scientific Discovery

Economic Opportunity

National Security



For More Info: WWW.NASA.GOV